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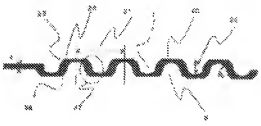
(54) MANUFACTURING METHOD AND DEVICE FOR SEPARATOR FOR SOLID POLYMER FUEL CELL

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a separator accepting a press working and applicable to a low- cost slid polymer fuel cell of high durability and also offer a manufacturing method and device for such separators.

SOLUTION: The separator for the solid polymer fuel cell has a flat portion at the periphery and is furnished except periphery with projections 8 and recesses 7 to constitute gas passage, and in the manufacturing method of this separator, the material is processed as a preliminary shaping process so as to have a section shape with repeated projection and recesses continuously and further into a section shape with final repetitive projections and recesses. and also such conditions should met that the radius R of curvature < half angle start > p < half angle end > of the should part 23 having a curved surface 27 to constitute a vertical wall part 37 of the separator during preliminary shaping than the corresponding value during final shaping and that the center of the vertical wall part during the preliminary shaping is made identical to the corresponding central part when the final shaping process is made, and thereby the shoulder part is prevented from cracking or rupture in the press working process, and also it is possible to secure flat parts 20 easily on the outer surfaces of the projections and recesses.



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CLAIMS

[Claim(s)]

[Claim 1]In a manufacturing method of a separator for polymer electrolyte fuel cells which has a flat part on the outskirts and has heights and a crevice where a portion except the circumference serves as a gas passageway, A separator manufacturing method for polymer electrolyte fuel cells fabricating material to repetition sectional shape of continuous heights and a crevice as preforming, and fabricating to repetition sectional shape of heights final after that and a crevice.

[Claim 2]A curvature radius of a shoulder which has a curved surface which forms a wall portion at the time of preforming is larger than a curvature radius of a shoulder which has a curved surface which forms a wall portion at the time of the last shaping, And the separator manufacturing method for polymer electrolyte fuel cells according to claim 1 performing preforming and the last shaping so that the central part of a wall portion at the time of preforming and the central part of a wall portion at the time of the last shaping may be in agreement.

[Claim 3]It is equipment for enforcing the separator manufacturing method for polymer electrolyte fuel cells according to claim 1 or 2, It has common die-press equipment of an up-and-down couple which performed repetition sectional shape of heights of preforming material, and a crevice, and irregularity working of similar figures to the surface in the preceding paragraph, A separator manufacturing installation for polymer electrolyte fuel cells having common die-press equipment of an up-and-down couple which performed repetition sectional shape of heights of a separator, and a crevice, and irregularity working of similar figures to the latter part on the surface.

[Claim 4]It is equipment for enforcing the separator manufacturing method for polymer electrolyte fuel cells according to claim 1 or 2, It has a draft roll of an up-and-down couple which performed repetition sectional shape of heights of preforming material, and a crevice, and irregularity working of similar figures to the surface in the preceding paragraph, A separator manufacturing installation for polymer electrolyte fuel cells having a draft roll of an up-and-down couple which performed repetition sectional shape of heights of a separator, and a crevice, and irregularity working of similar figures to the latter part on the surface.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the manufacturing method and equipment of a separator which are used for the polymer electrolyte fuel cell used for the car which makes electric power a direct driving source, a small-scale power generation system, etc.
[0002]
[Description of the Prior Art]From the rise of consciousness to environmental protection, the electric drive type car by the polymer electrolyte fuel cell which used hydrogen from the present internal-combustion engine using a fossil fuel, and the shift to a distributed cogeneration system are considered globally. In order for such new technology to enable it to use generally widely, it is necessary to promote the technical development in connection with low-cost-izing and high-reliability-izing also including a fuel system. In recent years, development of the fuel cell for electromobiles is beginning to progress quickly ignited by a development success of solid polymer material.
[0003]With a polymer electrolyte fuel cell, the conventional alkaline fuel cell, a phosphoric acid type fuel cell, It is a fuel cell which is characterized by using the organic matter film of a hydrogen ion selection transmission type as an electrolyte unlike a fused carbonate fuel cell, a solid oxide fuel cell, etc., It is a system which takes out electric power by controlling a reaction with oxygen in the air electrochemically using the hydrogen gas etc. which were obtained by refining of alcohols besides pure water matter to fuel. Since it fully functions, the electrolyte is being fixed in the film, even if thin and solid polymer membrane will function as an electrolyte, if the dew point in a cell is controlled, It is also the feature that it is not necessary to use a medium with mobility, such as an aqueous solution system electrolyte and a fused salt system electrolyte, and it is simplified compactly and the cell itself can be designed. the separator in which a polymer electrolyte fuel cell has a channel of hydrogen, a fuel electrode, solid polymer membrane, and air (oxygen) -- the stack which laminated this single cell actually is used by using as a single cell sandwich structure which consists of a separator with the channel of air (oxygen) very much. Therefore, both sides of a separator have the independent channel and, in one side, another [hydrogen and] one side serves as air and a generated channel of water.
[0004]As a component of the polymer electrolyte fuel cell which works in the field below the boiling point of a

cooling water solution, In order to form that temperature is not so high, that it is possible to fully demonstrate corrosion resistance and endurance under the environment, and still more arbitrary channel form, have used the material of a carbon system, processing it by cutting etc., but. Aiming at low-cost-izing or a miniaturization, i.e., the thinning of a separator, the technical development about application of stainless steel or titanium is progressing more

[0005]As stainless steel for fuel cells, conventionally JP,H4-247852,A. There is stainless steel for fuel cells which works in the melting carbonate environment where high corrosion resistance is required as indicated by a 4-358044 gazette, a 7-188870 gazette, a 8-165546 gazette, a 8-225892 gazette, 8-311620 gazette, etc. Invention of the solid oxide fuel cell material which works at the elevated temperature of hundreds of times has been made as indicated by JP,H6-264193,A, a 6-293941 gazette, 9-67672 gazette, etc.

[0006]JP,H10-228914,A has disclosed the technology which the separator for fuel cells having formed the swelling molding part which turns into an inner periphery from many unevenness by carrying out press forming of the stainless steel (SUS304) for the purpose of obtaining the small separator for fuel cells of contact resistance with the electrode of a unit cell, and forming a 0.01-0.02-micrometer-thick gold plating layer in the swelling tip side edge of a swelling molding part is indicated, makes it intervene between the unit cells which had the separator for fuel cells laminated when forming a fuel cell as the directions, allocates so that the electrode of a unit cell and the gold plating layer formed in the swelling tip side edge of a swelling molding part may contact, and forms a reactant gas passage between the separator for fuel cells, and an electrode. In JP,H5-29009,A, in order to process it inexpensive, the hole difference bipolar board of the corrugated form which carried out press working of sheet metal is indicated. In JP,2000-202532,A, a plate is put between a metallic mold and the manufacturing method which compresses a metallic mold with a reduction roll is indicated.

[0007]however, when the polymer electrolyte fuel cell was actually made as an experiment based on such technology, it turned out that there are the following technical problems of five points.

a) In the environment of a polymer electrolyte fuel cell where long term durability is searched for, it may become insufficient and it is necessary to raise content, such as Cr, nickel, and Mo, by SUS304 which is a general general-purpose steel type as an alloy content of the separator made from stainless steel as the measure

b) In the case of the stainless steel which raised alloy composition, such as Cr, nickel, and Mo, only by the method of gold-plating wet between a gold plating layer and a stainless steel substrate, it may remain without returning the passive state oxide film of stainless steel thoroughly during plating treatment, resistance between layers between stainless steel and a gold plating layer may arise, and it may become a cause of power loss. It is necessary to make the precious metals adhere as the measure, removing a coat.

c) Although the separator assumes the form in which the swelling molding part which turns into an inner periphery from many unevenness by press forming was formed, If processing of the component concerned which actually has a flat part in 4 rounds is tried, a ductility crack is produced in the swelling molding part which consists of unevenness, and especially the corner of an uneven part bends, and since distortion becomes large, it will tend to produce a fracture. Since processability falls compared with SUS304, the stainless steel

which raised alloy composition for the improvement in long term reliability is difficult to carry out press forming to this form. A touch area with an electrolyte membrane becomes it small that a section is corrugated form, and the fuel cell characteristic falls.

d) Press load increases and the method of fabricating detailed unevenness by press forming has the problem of requiring large-scale equipment, when a separator is enlarged.

e) The manufacturing methods which compress a metallic mold with a roll are opening and closing of a metallic mold, material handling, etc., and since it is that productivity is low and the rigidity of a metallic mold, there is a problem that it becomes difficult to add draft load with sufficient accuracy.

[0008]

[Problem to be solved by the invention]This invention persons have already shown JP,2000-256808,A, Tokuganhei11-170142, etc. the solving means to the problem of said a or b. Therefore, it aims at providing the manufacturing method, manufacturing installation, and polymer electrolyte fuel cell of the separator in which press working of sheet metal is possible applicable to a low cost and high durability type polymer electrolyte fuel cell in view of the problem of said c, d, and e in this invention.

[0009]

[Means for solving problem]The place which was made to complete this invention and is made into the summary as a result of examining the material action at the time of press forming in detail based on the operation principle of a polymer electrolyte fuel cell, in order to solve above-mentioned SUBJECT is as follows.

(1) In the manufacturing method of the separator for polymer electrolyte fuel cells which has a flat part on the outskirts and has the heights and the crevice where the portion except the circumference serves as a gas passageway, A separator manufacturing method for polymer electrolyte fuel cells fabricating material to the repetition sectional shape of continuous heights and a crevice as preforming, and fabricating to the repetition sectional shape of heights final after that and a crevice.

(2) The curvature radius of the shoulder which has a curved surface which forms a wall portion at the time of preforming, last -- shaping -- the time -- a wall portion -- forming -- a curved surface -- having -- a shoulder -- a curvature radius -- large -- and -- preforming -- the time -- a wall -- a portion -- the central part -- last -- shaping -- the time -- a wall -- a portion -- the central part -- being in agreement -- as -- preforming -- and -- last -- shaping -- carrying out -- things -- the feature -- carrying out -- the above -- (-- one --) -- a description -- a polymer electrolyte fuel cell -- ** -- a separator -- a manufacturing method .

(3) It is equipment for enforcing the separator manufacturing method for polymer electrolyte fuel cells the above (1) or given in (2), It has common die-press equipment of the up-and-down couple which performed repetition sectional shape of the heights of preforming material, and a crevice, and irregularity working of similar figures to the surface in the preceding paragraph, A separator manufacturing installation for polymer electrolyte fuel cells having common die-press equipment of the up-and-down couple which performed repetition sectional shape of the heights of a separator, and a crevice, and irregularity working of similar figures to the latter part on the surface.

(4) It is equipment for enforcing the separator manufacturing method for polymer electrolyte fuel cells the

above (1) or given in (2), it has a draft roll of the up-and-down couple which performed repetition sectional shape of the heights of preforming material, and a crevice, and irregularity working of similar figures to the surface in the preceding paragraph. A separator manufacturing installation for polymer electrolyte fuel cells having a draft roll of the up-and-down couple which performed repetition sectional shape of the heights of a separator, and a crevice, and irregularity working of similar figures to the latter part on the surface.

[0010]

[Mode for carrying out the invention]Below, the details of this invention are explained. An example of the concrete laminated structure of the separator [in / again / for the example of the top view of the separator 1 manufactured with the method and equipment of this invention / to drawing 1 / the Mizobata part 6] 1, the seal plate 10, and the carbon fiber charge collector 11 that is electrodes is shown in drawing 2 and drawing 3. Here, the fuel gas or oxygen (air) containing the hydrogen supplied from the incurrent pores 2 and 3 of gas flows only through crevice surface side of separator 7, or heights rear-face side 8, respectively, and is discharged from the discharge hole 4 or 5. An arrow shows the flow of the gas by the side of the surface in the Mizobata part in drawing 2. In the Mizobata part, it is possible to control that gas short-circuits the angle of inclination of heights and a crevice to the downstream by giving a lenience-and-severity difference every other, to turn it up in the Mizobata part, to go over it all over the gas passageway of a separator, and to pass gas uniformly in form [writing / about 1 brush]. Since the rate of flow of gas can be raised, it becomes easy [discharge of the water generated by the oxygen side]. The seal plate 10 is more slightly [than the groove height of the separator 1] thick, and the short circuit to the downstream of gas is further controlled by enlarging slightly from the maximum angle of inclination of the Mizobata part which mentioned above the angle of the end face of the center-section "**" omission part of a seal plate.

[0011]Although the rate of flow in the parallel part of a slot falls a little as compared with the arrangement of drawing 1 mentioned above, the effect that a pressure loss decreases is acquired. Needless to say, the groove arrangement which gives a lenience-and-severity difference is not limited to two examples shown here, and should be arbitrarily chosen from the capability of the feed unit of gas, generation efficiency, etc. Thus, various passage patterns can be formed by giving a lenience-and-severity difference to the Mizobata part. Although graphite slab, a metal plate, etc. can be used for the construction material of a separator from electron conductivity and a corrosion-resistant and airtight viewpoint, it is made thinly and it is preferred that they are a product made from stainless steel in which press working of sheet metal is possible, or a product made from titanium.

[0012]The example of the structure of a fuel cell stack where said separator and the seal plate were used is shown in drawing 4. A single cell is formed with sandwiching the solid polymer membrane 12 by which the electrode catalyst was applied to both sides by the laminated structure of the separator 1, the seal plate 10, and the carbon fiber charge collector 11 that is electrodes. A fuel cell stack comprises repeating and laminating A cycle in a figure. There is generation of heat accompanying a reaction in a polymer electrolyte fuel cell, in order to maintain solid polymer membrane at a suitable temperature, it is necessary to cool a stack but, and. The slot of this separator is possible also for considering it as the channel of cooling water, and is a suitable interval of a stack cycle, it is inserting B cycle including a circulating-water-flow way, and cooling of a stack of it

is attained. The construction material of a seal plate has moderate elasticity, it should just be a material in which decomposition and plastic deformation do not break out below in the boiling point of cooling water, and silicon resin, butadiene rubber system resin, fluororesin, etc. can apply it, It becomes possible by binding tight a seal plate slightly thicker than a groove height to also follow minute modification of a separator etc. by the seal of the gas being carried out and having moderate elasticity. Although solid polymer membrane is pinched among a figure and it is considered as the form that the channel by the side of hydrogen and oxygen counters, the form that both cross may be sufficient, without being limited to this.

[0013]An example of detailed sectional shape of a separator fabricated from a charge of a plate by a manufacturing method concerning invention the above (1) and given in (2) is shown in drawing 5 and 6. Although a smaller thing of the groove period 21 of a separator is desirable from the homogeneity of gas supply, and a viewpoint of collecting efficiency and it is desirable for a touch area with a viewpoint of contact resistance reduction to an electrode to be large, if the groove period 21 becomes small as compared with board thickness, Also by making a curvature radius of an angle small, in order for bending distortion to increase and to increase a touch area, or enlarging the length of the flat part 20, distortion increases, it fractures during processing and shaping becomes difficult. Generally, the groove period 21 is 2-3 mm, and although about a maximum of 1-mm thing is used as a channel of a separator for fuel cells, a channel depth, When a metal plate of about 0.1-0 3 mm of board thickness was fabricated, as compared with board thickness, the shape of a quirk was detailed, and bending distortion of a corner became large and fractured by a corner during shaping in many cases. Since board thickness was small, compression buckling of the wall portion 37 arose with compression stress, and a crack was also generated. Then, in [as a result of making a metallic mold as an experiment about various form and performing press forming] a cross section of a gas passageway, It found out that it could fabricate without fracturing if it preforms so that it may become the repetition sectional shape of the continuous crevice 7 and the heights 8 before considering it as the last sectional shape which has the flat part 20 in a field of the outside of heights and a crevice.

[0014]Drawing 7 shows the sectional shape of charges of a plate, such as stainless steel after a preforming press, or titanium. In order to fabricate the charge of a plate to the repetition sectional shape of the continuous crevice 7 and the heights 8 as preforming and to prevent a crack of the wall portion 37 in the last press forming, and a fracture, It is made larger than curvature-radius R_f of the shoulder 23 of the separator used as the final shape which shows drawing 5 curvature-radius R_p of the shoulder 23 of the portion 27 which fabricates the wall portion 37 with a preforming press. Bend the shoulder 23 of the wall portion 27 with a tensile strain, distortion is overlapped, and thickness becomes small, if it carries out by one press forming, it will be divided and will become easy to produce a fracture, but. By enlarging curvature-radius R_p of the shoulder 23 of the portion 27 which fabricates the wall portion 37 with a preforming press, it can bend at the time of shaping and distortion can be reduced. Since bending press processing is attained without pulling since stretch forming is carried out, and adding distortion with shaping after a preforming press, a crack of the shoulder 23 of the wall portion 27 and a fracture do not occur. Since the flow of the material in a metallic mold is made smooth by furthermore performing a preforming press, the flat part 20 is easily securable after the last shaping.

[0015]From a viewpoint of contact resistance reduction, as for the width of the flat part 20, it is desirable for a touch area with an electrode to be large, by making it not less than 20% of the polar-zone project areas which form a channel preferably, contact resistance becomes small and its output of a fuel cell improves. In order to promote a chemical reaction, to acquire predetermined electromotive force on the other hand and to supply fuel gas to the whole electrode surface uniformly, it is preferred to consider it as 50% or less. In order to be divided and to secure the aforementioned flat part 20 without a fracture, Curvature-radius R_f of the shoulder 23 of the wall portion 27 of the separator which is final shape is made into one to 3 times of board thickness. It is desirable for the central part 39 of the wall portion of the separator by which curvature-radius R_p of the shoulder 23 of the wall portion 27 in a preforming press carried out by 2 to 4 times the curvature-radius R_f and the last shaping was carried out with the central part 39 of the wall portion of preforming material to be in agreement. As for the connection section of the flat part 20 and the shoulder 23, it is preferred to have the flection 26, and by having the flection 26, it can secure the touch area of the separator flat part 20 and the electrode (carbon fiber aggregate) 11, and can set it as predetermined contact resistance.

[0016]In press forming, a preforming press operator also like the last press operator, irregularity working of similar figures is mostly performed using the common metallic mold of the up-and-down couple given to the surface with the repetition sectional shape of the heights of the charge of a plate after a press, and a crevice, and 70 to 140% of the board thickness of the length of the clearance 38 of the punch 24 and the bottom part 25 is desirable. The portion corresponding to the shoulder 23 of the section of the separator shown in drawing 5 may perform press forming using the common metallic mold which is the sectional shape which makes an acute angle. The process of a press is not restricted to two processes of a final process like a preforming press operator, but may perform shaping of two or more processes. When using the material which the big strain induced transformation seen with austenitic stainless steel, such as SUS301 material, produces, a heat treatment process may be established between final processes like a preforming press operator, and material may be annealed at about 1000 **.

[0017]By rotating pressing down and making the charge of a plate transfer the pattern of the surface uneven part 35 with the draft rolls 30a and 30b for preforming of the couple which has processed unevenness on the surface, and the draft rolls 31a and 31b for the last shaping shows the example of the manufacturing installation which manufactures a separator continuously to drawing 9. Between the draft rolls 30a and 30b for preforming, and the draft rolls 31a and 31b for the last shaping, In order that the uneven pattern of the charge of a plate by which preforming was carried out may position in the position corresponding to the uneven pattern of the draft rolls 31a and 31b for the last shaping, the side guides 32a and 32b with which the slot about board thickness was cut are formed in the center section of the vertical roll.

[0018]The sprocket holes 33 are beforehand pierced and processed on the both ends of the charge of a plate in the fixed pitch, and the system positioned by the sprocket wheels 34a and 34b can be used for the charge positioning mechanism of a plate by which preforming was carried out. An example of the positioning mechanism by a sprocket wheel is shown in drawing 10. The arrow in a figure shows the transportation direction of the charge of a plate. With the draft rolls 30a and 30b for preforming of a couple and the draft rolls

31a and 31b for the last shaping into which the unevenness by charges of a plate, such as stainless steel or titanium, on the surface is processed. By rotating pressing down and making sheet metal transfer the surface uneven pattern 3, a separator can be manufactured continuously.

[0019]Drawing 11 is a mimetic diagram showing an example of the draft roll surface form for the last shaping. The form of unevenness of the draft rolls 31a and 31b for the last shaping, Heights and a crevice have repeated structure along the shaft orientations of a draft roll, That from which heights and a crevice serve as repeated structure along with the circumferencial direction of a draft roll (drawing 12), What (drawing 14) heights and a crevice besides the specific thing (drawing 13) from which an angle inclination is carried out and heights and a crevice serve as repeated structure made other arbitrary polygons, such as circular, an ellipse form, and a quadrangle, to the shaft orientations of a draft roll can be used. Although the shape of surface type of the draft roll for preforming differs in form a little [-- a tooth depth becomes small --] compared with the draft roll surface form for the last shaping, fundamental form is the same as that of the draft roll for the last shaping.

[0020]

[Working example]The uneven pattern as shown in drawing 15 was formed in the draft roll surface for the last shaping of 200 mm in diameter, and 300 mm in length a couple by machining. Sectional shape is shown in drawing 11 and the heights of the draft roll for preforming are semicircular state with a curvature radius of 0.3 mm.

A pars basilaris ossis occipitalis is a 1.0-mm-wide smooth side, and a channel depth is 0.5 mm.

The clearance 38 of a punch and a bottom part shall be 0.8 mm, and uneven parts are 250 mm in width, and 150 mm in length (arc length). On the other hand, the heights of the draft roll for the last shaping are convex configurations with a curvature radius of 0.1 mm.

A pars basilaris ossis occipitalis is a 1.0-mm-wide smooth side, and a channel depth is 0.5 mm.

The clearance 38 of a punch and a bottom part shall be 0.8 mm, and uneven parts are 250 mm in width, and 150 mm in length (arc length).

[0021]A board is continuously supplied using equipment as shown in drawing 9 from the coil of austenitic-stainless-steel SUS316 of 290 mm of board width, and 0.1 mm of board thickness, The crevice between the up-and-down draft rolls for preforming (roll gap) was processed by the crevice between 0.1 mm and the up-and-down draft roll for the last shaping (roll gap) being 0.06 mm. Construction material of the draft roll was set to SKD11. Construction material of the side guide was set to S45C, was made into a couple 80 mm in diameter, and 120 mm in length, and was installed 250 mm before the draft roll. The up-and-down draft roll established the rotation synchronous means by a servo motor, and it provided the high ball bearing of the accuracy class in the bearing of the draft roll so that a relative displacement might not be generated in a roll axial direction.

[0022]After the board fabricated without uneven shape's having broken and a fracture arising intermittently performed the drilling process for introduction of fuel gas, cooling water, etc., and discharge, it was cut for every predetermined length and has manufactured the separator of the unit cell. Even after cutting, generating of curvature or wrinkles was not seen but good form was obtained. Then, after performing a suitable surface treatment etc., when the fuel cell stack was constituted and the performance test was done, neither gas

leakage nor a leak was also generated, but functioning good as a fuel cell using the separator by the manufacturing method of this invention was checked. The press by the method of this invention the same uneven shape with a 250 mm[in width] x length of 150 mm as compared with the case where the usual press performs, divide -- boil the incidence rate of a fracture markedly and it falls -- the usual one-step press -- about 5000 tons, as opposed to thing load having been required for -- this invention -- about 40 tons It is a grade. It can manufacture with very inexpensive equipment.

[0023]

[Effect of the Invention]This invention is very effective as technology of enabling press-forming processing of high corrosion resistant stainless steel and titanium as a separator for polymer electrolyte fuel cells, and realizing a low cost polymer electrolyte fuel cell.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]It is an example of the top view of the separator manufactured by this invention.
[Drawing 2]It is a mimetic diagram showing the example of the laminated structure using the separator manufactured by this invention.
[Drawing 3]It is a sectional view of a laminated structure using the flat-surface enlarged drawing of the Mizobata part of the separator manufactured by this invention, and the separator of this invention.
[Drawing 4]It is a mimetic diagram showing an example which builds a polymer electrolyte fuel cell stack using the separator manufactured by this invention.
[Drawing 5]It is a mimetic diagram showing the detailed sectional shape of the separator manufactured by this invention.
[Drawing 6]It is a mimetic diagram showing the detailed sectional shape of another separator manufactured by this invention
[Drawing 7]It is a mimetic diagram showing the example of the sectional shape of the charge of a plate after the preforming press by this invention.
[Drawing 8]It is the sectional shape of the common metallic mold concerning this invention for fabricating a separator.
[Drawing 9]It is an example of the manufacturing installation of a separator with the draft roll of this invention.
[Drawing 10]It is a mimetic diagram showing an example of the positioning mechanism of the charge of a plate by a sprocket wheel.
[Drawing 11]It is a mimetic diagram showing an example of the draft roll surface form for the last shaping of this invention.
[Drawing 12]It is a mimetic diagram showing the example of another draft roll surface form of this invention.
[Drawing 13]It is a mimetic diagram showing the example of another draft roll surface form of this invention.
[Drawing 14]It is a mimetic diagram showing the example of another draft roll surface form of this invention.
[Drawing 15]It is a mimetic diagram showing the example of another draft roll surface form for the last shaping of this invention.
[Explanations of letters or numerals]

1: Separator 2 : fuel-gas-flow ON hole
3: Oxygen (air) incurrent pore 4 : fuel-gas-flow outlet
5: Oxygen (air) discharge hole 6 : Mizobata part
7: crevice (fuel gas flow route) 8: -- heights (oxygen (air) channel)
9: 4 rounds of separator flat part 10 : a seal plate
11: electrode (carbon fiber charge collector) 12: -- solid polymer membrane
13: Fuel gas feed port 14 : an oxygen (air) feed port
15: Fuel gas outlet 16 : oxygen (air) and a produced water outlet
17: Cooling water feed port 18 : a cooling-water-discharge mouth
19: Flow 20 of gas : a flat part
21: Groove period 22 : a channel depth
23: Shoulder 24 . a punch
25: Bottom part 26 : a flection
27: A portion which fabricates a wall portion
30a, 30b: A draft roll for roll preforming
31a, 31b: A draft roll for the last shaping
32a, 32b: A side guide
33: Sprocket holes
34a, 34b: A sprocket wheel
35: An uneven part
36: A linear shape pars basilaris ossis occipitalis
37: A wall portion
38: Clearance
39: The center of a wall portion

[Translation done.]

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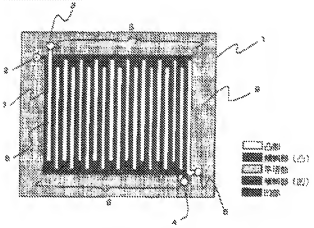
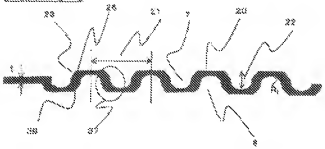
DRAWINGS

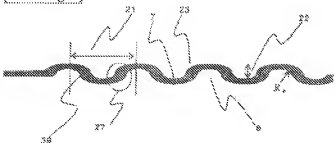
[Drawing 1]



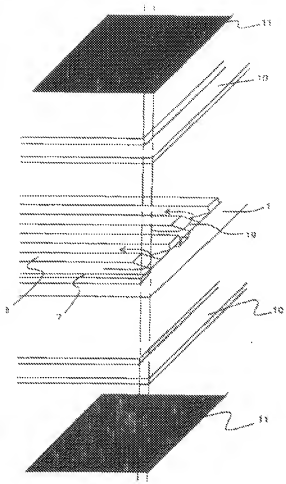
[Drawing 5]



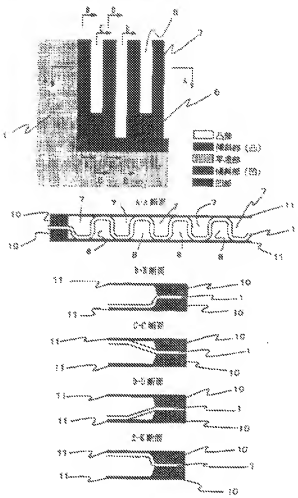
[Drawing 7]



[Drawing 2]



[Drawing 3]



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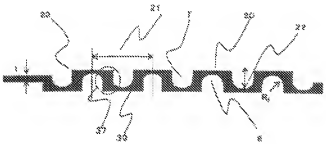

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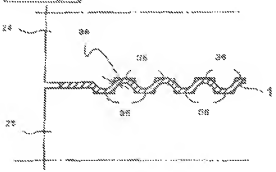

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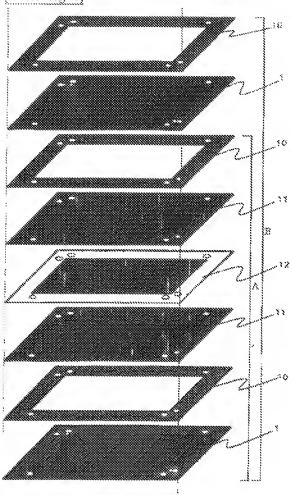

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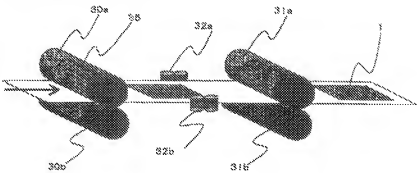
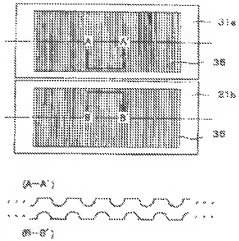
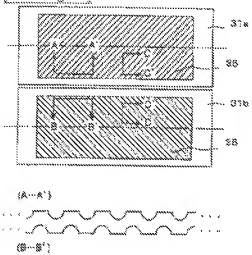


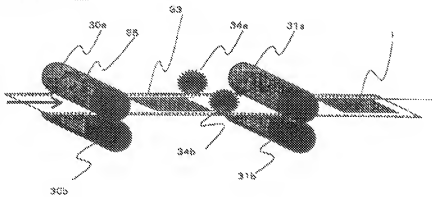
[Drawing 11]



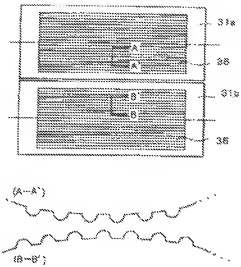
[Drawing 13]



[Drawing 10]



[Drawing 12]



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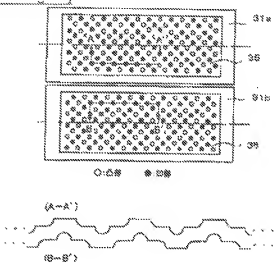
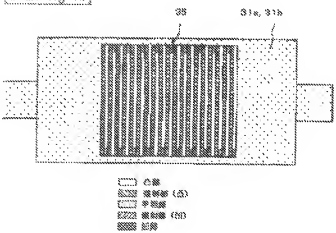


[Drawing 15]



[Translation done.]